

ABSTRAK

BimaJaya, Adam. 2025. Studi Komparasi Pemantauan Daya Keluaran Panel Surya dengan Variasi *Heatsink* sebagai Sistem Pendingin Pasif Berbasis *Internet of Things*. Skripsi. Tanjungpinang: Program Studi Teknik Elektro. Fakultas Teknik dan Teknologi Kemaritiman. Universitas Maritim Raja Ali Haji. Pembimbing I : Septia Refly, S.Pd., M.Si., Pembimbing II : Basyaruddin Ismail Harahap, S.Pd., M.T.

Peningkatan suhu menurunkan efisiensi panel surya, sehingga sistem pendingin pasif menjadi solusi efektif tanpa energi tambahan. Penelitian ini bertujuan untuk membandingkan efisiensi panel surya berdasarkan daya keluaran dan suhu permukaan, dengan menggunakan dua variasi desain *heatsink*, yaitu *heatsink* paralel dan *heatsink* pin, serta panel tanpa *heatsink* sebagai kontrol pembanding. Sistem ini dirancang dengan mikrokontroler ESP32, sensor suhu DS18B20, sensor arus dan tegangan INA219, RTC DS3231, dan modul SD card, yang memungkinkan pemantauan data secara berkala melalui platform ThingSpeak. Hasil pengujian menunjukkan bahwa panel dengan *heatsink* paralel mencatat efisiensi suhu tertinggi mencapai 7,92% dan menghasilkan efisiensi daya sebesar 15,65%. Sebaliknya, panel dengan *heatsink* pin hanya mencapai efisiensi suhu 1,72% dan bahkan menunjukkan efisiensi daya negatif sebesar -2,85%, menunjukkan bahwa sistem pendinginan tersebut tidak mampu meningkatkan efisiensi daya. Selain itu, sistem IoT yang digunakan menunjukkan kinerja pengiriman data yang baik dengan nilai rata-rata *Packet Delivery Ratio* (PDR) sebesar 99,85%, meskipun mengalami rata-rata *delay* sebesar 960,1 ms yang tergolong tinggi menurut standar TIPHON, diduga disebabkan oleh besarnya volume data yang dikirim secara berkala tanpa pengaturan interval yang optimal.

Kata Kunci : Panel Surya, Sistem Pendingin Pasif, Efisiensi Energi, *Internet of Things* (IoT)

ABSTRACT

BimaJaya, Adam. 2025. *Comparative Study of Solar Panel Output Power Monitoring with Heatsink Variations as a Passive Cooling System Based on the Internet of Things*. Thesis. Tanjungpinang : Study Program of Electrical Engineering. Faculty of Engineering and Maritime Technology. University of Maritim Raja Ali Haji. Supervisor I : Septia Refly, S.Pd., M.Si., Supervisor II : Basyaruddin Ismail Harahap, S.Pd., M.T.

An increase in temperature reduces the efficiency of solar panels, making passive cooling systems an effective solution without requiring additional energy. This study aims to compare the efficiency of solar panels based on output power and surface temperature using two variations of passive heatsink designs: parallel-fin heatsinks and pin-fin heatsinks, along with a control panel without any heatsink. The monitoring system was developed using an ESP32 microcontroller integrated with a DS18B20 temperature sensor, INA219 current and voltage sensors, a DS3231 RTC module, and an SD card module, enabling periodic data monitoring via the ThingSpeak platform. The test results showed that the panel equipped with a parallel-fin heatsink achieved the highest thermal efficiency at 7.92% and produced a power efficiency of 15.65%. In contrast, the panel with a pin-fin heatsink only achieved a thermal efficiency of 1.72% and even showed a negative power efficiency of -2.85%, indicating that this cooling method was ineffective in improving power output. Additionally, the implemented IoT system demonstrated reliable data transmission performance, with an average Packet Delivery Ratio (PDR) of 99.85%, although it experienced an average delay of 960.1 ms, which is considered high based on the TIPHON standard. This delay is presumed to be caused by the large volume of data sent periodically without an optimized transmission interval.

Keywords: *Solar Panel, Passive Cooling System, Energy Efficiency, Internet of Things (IoT)*